

AN EXPERIMENTAL CONTRIBUTION TO INTESTINAL SURGERY WITH SPECIAL REFERENCE TO THE TREATMENT OF INTESTINAL OBSTRUCTION.¹

(CONTINUED.)

By NICHOLAS SENN, M. D., PH. D.,

OF MILWAUKEE.

ATTENDING SURGEON TO THE MILWAUKEE HOSPITAL, PROFESSOR OF THE PRINCIPLES AND PRACTICE OF SURGERY AND CLINICAL SURGERY IN THE COLLEGE OF PHYSICIANS AND SURGEONS, CHICAGO, ILL.

NOTHNAGEL'S TEST.

IN experimenting upon animals for the purpose of studying the functions of the intestinal canal in health and disease, Nothnagel made the discovery that when the salts of potash are brought in contact with the serous surface of the bowel circular constriction takes place, and when the peritoneal surface is touched with a crystal of common salt ascending peristalsis is produced. The sodic chloride test I applied in 16 cases, and found Nothnagel's observations corroborated in 15 cases, by subsequent anatomical examination. In the remaining case where a wrong conclusion was drawn the error might have been due to a faulty observation, or the observation was not continued for a sufficient length of time. If, in the human subject these observations could be verified, it would be of great practical importance to surgeons in operations on the intestinal canal whenever it becomes necessary to determine which is the ascending or descending part of the bowel.

Experiment 45. Dog, weight 30 pounds. Circular section of ileum and immediate enterorrhaphy by invagination with rubber ring and two catgut sutures. Intussusceptum invaginated not more than a quarter of an inch. A few days after the operation stools mixed with blood, no other unfavorable symptoms. Animal killed fourteen days

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after operation. Wound united firmly. A number of omental and intestinal adhesions. A small abscess in mesentery at point of operation. No obstruction of any kind. On opening the bowel the walls at site of operation were very thick corresponding to the three intestinal coats, which had become considerably attenuated. The inner surface shows the point of junction of the intussusceptum with the intussusciens in the shape of a circular ring of mucous membrane. The most contracted portion is large enough to admit the little finger.

Experiment 46. Dog, weight 15 pounds. Section of ileum and circular enterorrhaphy with rubber ring and two catgut sutures. Depth of invagination one-third of an inch. No unfavorable symptoms after operation. Animal killed after seven days. Wound completely united. Firm union of visceral wound; no gangrene of intussusceptum. Rubber ring retained *in situ* by catgut sutures, which are easily torn. Upper end of rubber ring matted with hair. No obstruction. Lumen of bowel somewhat contracted by a circular ridge of mucous membrane, which indicates the junction of the two invaginated ends of the bowel.

TRANSPLANTATION OF OMENTAL FLAP.

In most all post-mortem examinations of specimens from operations on the intestines, I observed that the omentum was adherent over a greater or less surface at the seat of suturing. I also observed that perforations never occurred wherever this additional protection to the peritoneal cavity had formed. To anticipate nature in protecting the peritoneal cavity in this manner I commenced to transplant an omental flap about an inch in width and sufficiently long to reach around the bowel, over the neck of the intussusciens, where it was fastened on the mesenteric side by two catgut sutures. The flap was taken either from the margin of the omentum or from its middle, care being taken to take some portions supplied with a vessel of considerable size. Its base was left attached to the omentum, all bleeding points were carefully tied with catgut ligatures. The two catgut stitches used for its fixation were passed twice through the flap, its base and free end, and the mesentery in such a way that when tied the direction of the suture corresponded to the course of the mesenteric vessel, so that after tying they would not interfere with the vascular

supply of the bowel. When the flap was taken from middle of the omentum, the lateral halves were united with one or two catgut sutures before closing the abdominal wound.

Experiment 47. Dog, weight 40 pounds. Ileum divided 18 inches above ileo-caecal region, and the ends united by invagination with rubber ring and two catgut sutures. Transplantation of omental flap one inch in width around the whole circumference of the bowel over neck of intussusciens, fixation with two catgut sutures on mesenteric side. Invagination one-third of an inch in depth. Animal killed two weeks after operation. Abdominal wound perfectly healed. Omental flap firmly adherent to bowel over neck of intussusciens. Bowel at seat of operation much thickened; rubber ring gone; lumen of bowel at its most contracted point large enough for the passage of the little finger.

Experiment 48. Dog, weight 20 pounds. Complete division of ileum and immediate union of divided ends by invagination with rubber ring and two catgut sutures. Transplantation of omental flap two inches in width over the neck of the intussusciens. On third day stools mixed with blood. Died on the 5th day. Wound not united; omental flap firmly adherent except at a small point on mesenteric side where a minute perforation had taken place from circumscribed gangrene of the intussusceptum. Rubber ring only loosely held by one of the sutures. Lumen in invaginated portion quite narrow, but permeable.

Experiment 49. Dog, weight 15 pounds. Complete section of ileum and union of divided ends by invagination. The rubber ring used was only one-third of an inch wide, while formerly none were used less than half an inch in width. Neck of intussusciens protected by an omental flap two inches wide. The dog remained perfectly well, and was killed 25 days after operation. Abdominal wound completely healed, covered on the inner side by adherent omentum. Rubber ring gone. Lumen of bowel at most contracted point readily admits the little finger. No signs of obstruction. Omental flap adherent throughout.

Experiment 50. Dog, weight 22 pounds. Division of ileum and suturing in usual manner by invagination with rubber ring and two catgut sutures; transplantation of omental flap.

The dog remained perfectly well and was killed 23 days after operation. A number of intestinal adhesions produced several flexions. Point of operation four feet above the ileo-caecal region. Omental

flap firmly adherent to bowel throughout. Rubber ring gone. Lumen of bowel in invaginated portion quite large. The invaginated portion atrophic and retracted so that it appears in the shape of a firm ring and indicated in the interior by a circular prominence of the mucous membrane. No evidence of obstruction.

Experiment 51. Dog, weight 15 pounds. Complete division of the ileum and reunion of ends by invagination. Transplantation of omental flap two inches in width over neck of intussusciens, two cat-gut fixation sutures. Second day after operation stools bloody. After this time all functions normal. Animal killed forty-four days after operation. Point of operation four feet below the pylorus. The invaginated portion atrophied and retracted to such an extent that the bowel at this point only presents a thickened ring with its lumen only slightly narrowed by a circular ridge of mucous membrane. Omental flap firmly adherent all round and greatly atrophied.

REMARKS.—In circular enterorrhaphy, as in cases of intestinal wounds of any kind, the ideal of any operation should be to bring in continuous uninterrupted apposition a large surface of serous membrane, without, at the same time, interfering with the vascular supply of the parts which it is intended to bring together for permanent union by cicatrization. If in employing the Czerny-Lembert sutures more than a few lines of the margins of the bowel is inverted and included between the two rows of sutures, there is great danger of causing primary traumatic stenosis by the projecting circular ring in the lumen of the bowel. The narrowing of the lumen of the bowel must be as great, if not greater, than after invagination. That the second row of sutures has often been the cause of gangrene of the inverted margin of the bowel would not be difficult to prove by many post-mortem records and specimens. By invaginating to the depth of a quarter or third of an inch accurate coaptation is secured of the corresponding serous surfaces between the intussusceptum and intussusciens, which is made more secure and effective by the elastic pressure exerted by the rubber ring. This method of coaptation furnishes a large peritoneal surface of peritoneum for immediate union by cicatrization. With perhaps one exception, all of my experiments have shown that when cat-gut is used for invagination sutures none of the failures were at-

tributable to their presence. On the inner side of the bowel the rubber ring is drawn against the puncture, and would thus furnish a mechanical protection against the escape of fluids along these minute canals; besides the swelling of the catgut where it becomes softened by the fluids of the tissues would most effectually plug the punctures until a permanent plug is furnished by the granulations which in time completely remove the catgut by substitution and close the punctures permanently by a minute cicatrix. One great advantage of the rubber ring consists in its furnishing absolute protection to the bowel against pressure by the invagination sutures during the invagination, and subsequent traction from peristaltic contraction should the latter cause tension of the sutures, an occurrence which is not likely to arise if the invagination has been properly done. A circular enterorrhaphy as described above can be done in 15 minutes which certainly compares very favorably with any other procedure as far as time is concerned. In the description of a number of the specimens it has been distinctly stated that injurious results followed the stenosis caused by the invagination, and this might be urged as an argument against the safety and applicability of the operation. As compared with the human subject the dog is an unfavorable animal for circular enterorrhaphy by invagination. In the first place, the walls of the bowel are much thicker in proportion to its lumen than in man, a condition which necessarily seriously affects the lumen of the intussusception. Again the dogs were allowed to eat what they desired before and after the operation, and the quantity was not limited, consequently a great deal of indigestible substances, often of the coarsest kind, as straw, fragments of wood, or bone, hair, etc., found their way into the intestinal canal, and in a number of cases were arrested at the point of narrowing in the bowel, where they gave rise to the formation of an enterolith. In one instance death resulted clearly from intestinal obstruction from such a cause. In men the coats of the bowel being thinner and the lumen correspondingly larger, invagination is done with greater ease, and the danger from stenosis could hardly come into question as the fluid contents of the small intestines would pass readily through the rubber tube.

Some of the older specimens prove that the traumatic stenosis caused by the invagination gradually diminishes by atrophy of the invaginated portions which finally only appear as a prominent ridge of mucous membrane on the inner surface of the bowel, the remaining coats having completely or nearly disappeared by retrograde metamorphosis and absorption. In the healing of all wounds one important condition for an ideal result is rest. The rubber ring in the intussusceptum secures this important condition for the invaginated portion, as the elastic pressure must overcome peristaltic action and secure for this segment of the bowel, as near as possible absolute physiological rest. The danger of stenosis after invagination is greatest as soon as inflammatory swelling makes its appearance, a day or two after the operation, and the rubber ring is again in the right place to prevent any undue swelling by affording a gentle support for the invaginated portion, which cannot fail in preventing undue venous engorgement and œdema, which would otherwise follow the invagination. It serves both the purpose of a splint and an elastic bandage. After union of a bowel by invagination with a rubber ring peritoneal sutures are superfluous as the invagination itself most effectually prevents any escape of intestinal contents by the valvular action of the invaginated portion; at the same time the serous surfaces are kept in permanent and uninterrupted contact by the elastic pressure on part of the rubber ring.

Although the experiments have demonstrated the safety of the catgut invagination sutures in operating upon dogs, the same innocuity might not attend operations after intestinal resections for obstruction, as in such cases the coats of the bowel are almost without exception very much attenuated, and consequently the danger of extravasation along the needle punctures would be increased. Very recent trials have satisfied me that invagination after circular resection can be done with the rubber ring with facility and probably greater safety by dispensing with the invaginating sutures and adopting the following plan: The lower end of the intussusceptum is lined with a soft rubber ring about one quarter to one-third of an inch in width, and its lumen of sufficient size to afford

free transit to the intestinal contents. The lower margin of the ring is stitched to the end of the intussusceptum by a continued fine catgut suture. The ends of the bowel are now brought in contact and fastened together with four catgut sutures which are placed equidistant from each other. Invagination is now made by gently pushing the ends of the bowel in opposite directions being careful to push the ring sufficiently deep so that its upper margin is grasped by the neck of the intussusciens. A few superficial sutures are applied simply for the purpose of preventing disinvagination: the four catgut sutures act as invagination sutures, and at the same time prevent ectropium of the mucous membrane of the lower end of the bowel during and after invagination. With proper facilities and good assistance, a circular enterorrhaphy can be made in this manner without using invagination sutures in ten minutes, and by using not more than four retention sutures the blood supply to the inverted portions is not impaired, and at the same time the two ends of the bowel have been joined together by a large surface of peritoneum, which is held in accurate contact for rapid union by granulation and cicatrization. The advantages that are derived from covering a sutured intestinal wound by an omental flap are self-evident. The procedure is simply an imitation of nature's process in protecting the peritoneal cavity against perforation and in hastening the healing of the visceral wound. An adherent omentum secures rest for the part to which it has become attached. As the omental flap becomes firmly adherent before definitive healing of the visceral wound has taken place, it furnishes additional protection, and in the event of a small perforation it guards against perforative peritonitis by mechanically preventing the entrance of pus into the peritoneal cavity. Should pus reach the omental flap after it has become firmly adherent it is not very probable that perforation would take place through the two layers of peritoneum furnished by the adherent omental flap, and the subsequent healing of the perforation of the bowel would be most likely to take place. I shall again refer to this subject under the head of "Omental Grafting."

IV. INTESTINAL ANASTOMOSIS.

By an intestinal anastomosis we understand a condition of the intestinal canal where on account of an obstruction or complete occlusion, the intestinal contents are directed into a segment of the bowel below the seat of obstruction or occlusion through a fistulous opening between the bowel above and below the seat of partial or complete occlusion. The idea of establishing such a communication between the bowel above and below the seat of obstruction originated with Maisonneuve, who, without testing the new procedure first on animals, operated on two cases, but as the result in each case was fatal, he seems to have become discouraged and abandoned the operation, and never published the communication on this subject which he had in preparation. In the Surgical Society of Paris, his proposition met with violent opposition from his contemporaries, who argued that the excluded portion of the intestine would become the seat of faecal accumulation, which, even if the operation were a success would subsequently destroy the life of the patient. The subject was revived in 1863 by Hacken, who under the directions of Adelmann made some experiments on dogs. For a long time the operation was completely forgotten until E. Hahn, of Berlin, very recently alluded to it again in commenting on his two cases of excision of the colon where circular enterorrhaphy could not be performed, and where an artificial anus was established. Both patients recovered from the operation, but all attempts to close the preternatural opening proved futile. The results of my experiments have shown conclusively that the fear of accumulation of faeces in the excluded portion of the intestine, that is the intervening portion containing the seat of obstruction and extending on each side as far as the new opening by which the anastomosis has been established, is unfounded. If this objection can be laid aside, it becomes evident that the operation of establishing intestinal anastomosis has a great future, and will soon become an established procedure in the treatment of intestinal obstruction, and as a substitute for circular suturing in some forms of injuries of the intestines, which require excision. When I first made my experiments of establish-

ing intestinal anastomosis, I made the operation by making an incision an inch and a half to two inches in length through the convex surface of each bowel, and sutured the wounds together by Czerny-Lembert sutures the same as in making a circular enterorrhaphy. The results soon showed that the operation was attended by the same dangers as suturing after circular resection, that is, gangrene of the margins of the bowel and perforation. Dr. M. E. Connel, Superintendent of the Milwaukee County Hospital, suggested the use of perforated plates for making the lateral apposition in place of suturing. A few crude experiments were made with perforated discs of lead, wood, gutta percha, and leather, and the results soon satisfied us of the expediency and greater safety of uniting the intestines in this manner. Although the first experiments were very imperfect, and faulty in technique, almost every animal recovered. In the first experiments no needles were used. Around the oval perforation four catgut or silk sutures were tied; a slit was made in the bowel on the convex side parallel with its axis and large enough to permit the passage of a plate about an inch in width and about 2 1-2 inches in length. After making the incision and introducing the plate above and below the seat of obstruction the two wounds were brought into apposition, and the corresponding strings tied together with sufficient firmness to bring the flattened surfaces into accurate coaptation. The threads were cut short and the ends pushed inward out of sight. Experience showed that although the apposition was good, a tendency was observed on the part of the margins of the wound to evert on account of the bulging of the mucous membrane. I consequently modified the operation by arming the lateral threads with a needle with which the margin of the incision about the middle of the wound was transfixed. This proved a step in the right direction, as the lateral sutures completely prevented eversion of the margins of the wound, at the same time they fixed the plates in their position, and lastly at once transformed the longitudinal slit into an oval foramen of sufficient size for the free passage of intestinal contents. After many trials with different kinds of materials for the plates, I came to the conclusion that decalcified or partially decalcified

bone plates preserved after the decalcification in pure alcohol served the best purpose.

DIRECTIONS FOR PREPARING BONE-PLATES.

The compact layer of an ox's femur or tibia is cut with a fine saw into oval plates, one-fourth of an inch in thickness, two and one-half to three inches in length, and an inch in width. The plates are then decalcified in a ten per cent solution of hydrochloric acid, changed every twenty-four hours until they have become sufficiently soft that they can be bent in any direction without fracturing. After decalcification they are washed by letting water flow over them from three to six hours so as to remove the acid. The plates are then covered with porous paper and compressed between two pieces of tin until they are perfectly dry. If during the process of drying the plates are not compressed between two smooth surfaces they become distorted by warping. The hardened plates are next drilled several times in a straight line in the centre, and the openings enlarged and connected with a file, until the perforation is five-eighths inch in length and about one-eighth to one-sixth inch in width. The sharp margins of the plate and perforations are removed with a file. With a fine drill the four perforation for the sutures are made near the margin of the oblong perforation, one at each end and one at each side. For preservation the plates are kept in absolute alcohol. When the plates are to be used they are washed in a two per cent solution carbolic acid, and the threads or sutures attached by threading two fine sewing needles, each with a piece of aseptic silk, twenty-four inches in length, which are tied together. The threads are then fastened to the surface of the plate by another thread passing through the perforations in the shape of a loop and fastened at the back.

Instead of describing the experiments in their chronological order, I will enumerate them according to the part of the intestine operated upon, commencing with the lower portion of the intestinal tract.

I. GASTRO-ENTEROSTOMY.

As gastro-enterostomy is an operation which establishes an anastomosis between the stomach and the upper portion of the intestinal canal, with exclusion of the duodenum, and sometimes a portion of the jejunum, and is performed in cases of obstruction in the pylorus or duodenum, it comes within the legitimate sphere of this paper. Gastro-enterostomy, as heretofore described and performed, is an operation attended by many difficulties, and requires even in the hands of an expert an hour or more for its execution. As this operation is only done in cases greatly debilitated by disease and long suffering, anything which will simplify the technique and shorten the time must be looked upon as an improvement. An operation that can be done in ten minutes instead of an hour or two, and which even furnishes better conditions for the healing of the visceral wounds must take the place of the more complicated procedures which so far have only been practised in the hands of the most experienced surgeons.

Experiment 52. Dog, weight 25 lbs. Incision made through linea alba from xiphoid cartilage to near umbilicus. Omentum pushed to one side, and the stomach drawn forward into the wound; near the middle of its anterior surface a longitudinal incision was made, two inches in length, and a perforated gutta percha plate to which four medium-sized juniper catgut sutures were attached, was introduced. The lateral sutures, armed with needles, were passed through the entire thickness of the walls of the stomach, half way between the angles of the wound. A similar incision was made into the intestine at the junction of the duodenum with the jejunum: the same kind of plate introduced and the margins of the wound punctured by the lateral armed sutures when the two wounds were brought *vis a vis* and the corresponding sutures tied. In tying the sutures the lower lateral suture is tied first, and the threads cut short; next the sutures corresponding to each angle of the wound are tied, and lastly the upper lateral. The serous surfaces of the stomach and intestine over an area corresponding to the size of the plates were brought into accurate permanent contact by the tying of the sutures. The stomach was replaced and the abdominal wound closed. The animal was allowed to eat immediately after the operation, and manifested no signs of illness.

or pain, and was killed seven days after operation. Abdominal wound healed. Omentum adherent to its inner surface. Union between stomach and bowel firm over the entire surface of approximation. Plates detached, the one in the bowel had passed, while the other was found loose in the stomach. The new opening large enough to pass the index finger.

Experiment 53. Dog, weight 50 lbs. The operation was performed in the same manner as in the previous experiment, but great difficulty was experienced in bringing the stomach forward, as this organ was distended to its utmost with an enormous quantity of solid food. Evacuation was effected through the incision, aided by attempts of the animal to vomit, the violent contractions of the stomach forcing the food toward the opening, from where it was removed with fingers and spoon. After the stomach was emptied it was washed out with warm water. For the stomach a bone plate, only partially decalcified, was used, while the approximation plate in the bowel was fully decalcified. The four approximation sutures were of catgut. Several portions of omentum, which were soiled during the emptying of the stomach, were excised. The abdominal cavity was thoroughly irrigated with warm water before the wound was closed. The animal died the next day, and on opening the abdomen it was ascertained that the immediate cause of death was hemorrhage, as the peritoneal cavity was filled with blood. The bleeding undoubtedly took place from the omentum, by slipping or loosening of one of the catgut ligatures.

Experiment 54. Medium sized dog. Operation performed in the same manner with decalcified bone plates and catgut sutures. The first two days the animal had several attacks of vomiting, subsequently showed no signs of suffering. Appetite good and stools regular. Killed 34 days after operation. Omentum adherent to inner surface of abdominal wound. At point of operation stomach is contracted, so that the organ presents an hour-glass appearance. Interior of the organ contains a large mass of hay and fragments of bone. New opening large enough to pass index finger. Union between stomach and bowel over entire surface of approximation. Water passed into the stomach, flows through the pyloric orifice and the new opening in a stream of equal size.

Experiment 55. Large bull-dog. Approximation of anterior surface of stomach with bowel by perforated gutta percha plates, and four catgut sutures. Length of visceral incisions, two inches. The day after operation animal vomited his dinner, subsequently no unfavorable symptoms. Animal killed fourteen days after operation. Abdominal

wound well united. Omentum adherent to wound, duodenum, liver and at point of operation. Firm adhesions between stomach and bowel. Water passed into the stomach, only passed through the pyloric orifice. On opening the stomach, it was found that the wound in the stomach and intestine had completely healed, the site of incisions being marked by a narrow firm cicatrix. The failure of obtaining an anastomotic opening between the stomach and intestine could only be attributed to one of two causes, viz., either the perforations in the plates were too narrow, or the needles of the lateral sutures included too much tissue ; either cause would bring about approximation of the margin of the wounds and permanent closure of the opening by granulation and cicatrization.

REMARKS.—All of the animals recovered, except in case of experiment 53, without any untoward symptoms, although they were allowed to eat immediately after the operation, and the diet was not selected or restricted at any time. In the fatal case death was caused from complications which had no connection with the gastro-intestinal opening. In all of the specimens examined the mucous membrane of the stomach and intestine which had been interposed between the approximation plates presented a healthy appearance, showing that the pressure of the plates had exercised no injurious effect on this structure. More recent experience with this operation on animals has revealed the fact that in the stomach a completely decalcified bone plate is digested almost completely in thirty-six to forty-eight hours. It would, therefore, appear advisable to use only partially decalcified bone which remains for a longer time, so that in case of delayed union the approximation would be maintained for a sufficient length of time. As these animals subjected to the operation recovered promptly, and under the most unfavorable conditions, we have every reason to believe that this operation will be attended by the same favorable results when done for pyloric or duodenal stenosis in man, where a careful preparatory and after treatment cannot fail to facilitate the operation and to improve the conditions for the formation of early adhesions and a speedy definitive healing of the wound. I have no hesitation in recommending it as a substitute for the more time-consuming and

less certain operation by the tedious and difficult method of double suturing which is now generally practised.

2. JEJUNO-ILEOSTOMY.

In this operation some form of intestinal obstruction, either complete by division of the bowel and closure of both ends, or partial, by making a volvulus, invagination or flexion in the vicinity of the juncture of the jejunum with the ileum, and intestinal anastomosis made by establishing a communication between the bowel above and below the obstruction. Before I made use of the perforated approximation discs this was accomplished by making an incision an inch and a half or two inches in length through the convex surface of the bowel above and below the obstruction and uniting the wounds by a double row of sutures. An operation of this kind usually lasted over an hour, while the rapid operation of coaptation by perforated discs seldom took more than fifteen minutes.

(a) JEJUNO-ILEOSTOMY BY SUTURING.

Experiment 56. Large cat. Invagination of ileum into ileum in a downward direction, and fixation of intussusceptum to neck of intussusciens by two fine catgut sutures to prevent spontaneous reduction. Intestinal anastomosis by establishing an opening an inch in length, suturing by Czerny-Lembert method. The animal never recovered from the shock of the operation, and died in less than twenty-four hours. Length of intussusceptum two inches, which, after the removal of the sutures, could not be reached by traction, as the bowel was firmly constricted by the neck of the intussusciens, and recent adhesions had formed. No peritonitis: suturing found perfect.

Experiment 57. Dog, weight 65 lbs. Intestinal obstruction by making acute flexions in upper portion of ileum, fixation of loops of intestine by fine catgut sutures. Intestinal anastomosis between jejunum and ileum by incision and double suturing. The animal died on third day with symptoms of perforative peritonitis. On close examination, one of the superficial approximation sutures had been passed through the whole thickness of the wall of the bowel, and it was here that perforation had taken place. Recent diffuse general peritonitis.

Experiment 58. Dog, weight 17 lbs. Descending invagination of ileum into ileum, length of intussusceptum three inches, fixation by

two catgut sutures. Formation of intestinal anastomosis between the bowel above and below the invagination by incision and double suturing. Animal died on third day with symptoms of perforative peritonitis. Abdominal wound not united. Adhesions at point of operation quite firm. Diffuse general peritonitis from a perforation which had been made by a sharp fragment of bone above the new opening. Intussusceptum not gangrenous.

Experiment 59. Dog, weight, 23 lbs. Intestinal obstruction was made by producing a volvulus in the upper part of the ileum. Restoration of continuity of intestinal canal by making a jejunoo-ileostomy by lateral apposition and double suturing. Day after operation intestinal discharges were bloody; after this time normal. Animal in perfect health when killed sixty-seven days after operation. The volvulus was found in same condition as after operation; the intestinal loop empty, atrophied and adherent to adjacent loops of intestine. Bowel above seat of obstruction and as far as the new opening empty. Intestinal tract above and below the obstruction presents no indication of the presence of an obstruction. New opening oval in shape and as large as the lumen of the bowel at that point.

Experiment 60. Large maltese cat. Intestinal obstruction by making two flexions in ileum, about eighteen inches apart, after this portion had been cleared of its contents. Flexions made by doubling the bowel toward its convex side, and fixing it in this position by fine catgut sutures. Jejunoo-ileostomy by lateral apposition and suturing. Vomiting day after operation; stools scanty the first few days, and later complete obstruction. Died nineteen days after operation. Wound completely united; no general peritonitis; flexions remained; bowel between them contained a slight amount of faecal matter. Bowel some distance above the new opening very much dilated, pointing to obstruction above new opening. On tracing the intestinal canal from above downward, this obstruction is seen to consist in acute flexion of the bowel by firm and extensive adhesions. New opening sufficiently large to admit the tip of the index finger, around the margins of which most of the deep sutures remain attached.

Experiment 61. Large cat. Obstruction made by two flexions in the ileum, the apices of which were united by catgut sutures. Intestinal anastomosis made by a jejunoo-ileostomy. For eleven days the animal remained in good condition, when symptoms of perforative peritonitis manifested themselves, and death ensued two days later. External portion of wound not united. Numerous omental and intestinal adhesions. Flexions retained and their apexes adherent to each

other by firm band of adhesion. Excluded portions above and below the obstruction empty. Two small perforations at point of suturing on anterior surface of bowel; remaining portion of wound firmly united. New opening sufficiently large to admit tip of index finger. Death from perforative peritonitis.

Experiment 62. Large, Newfoundland dog. Descending invagination of ileum into ileum to the extent of six inches; fixation of intussusceptum by two catgut sutures. Permeability of intestinal canal restored by making a jejunoo-ileostomy; wounds united by a double row of sutures. Intestinal discharges normal throughout. No rise in temperature. General condition as good as before operation, when killed on the twentieth day. Abdominal wound completely united; no peritonitis; omentum adherent at site of operation. Invagination had reduced itself, and its location was marked by an acute flexion caused by extensive adhesions. No accumulation of intestinal contents in excluded portions. The new opening, at least two inches in length, a few of the deep sutures remaining attached to its margins. This opening was partially obstructed by a mass of hair and fragments of bone. On passing a stream of water from above downward, the fluid passed through an opening in the centre of this mass into the lower portion of the ileum, but not through the portion that was invaginated. After this mass was removed, the fluid was found to pass through the portion that was invaginated, as well as through the new opening.

(TO BE CONTINUED.)